Energetic Phenomena IV: Demonstration of CME data usage

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Topics:
Description of the CME catalog
CME measurements
Plots and Movies
Caveats

The SOHO/LASCO CME Catalog

http://cdaw.gsfc.nasa.gov/CME_list

The Catalog Team

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1. Introduction

The SOHO/LASCO CME catalog contains all CMEs manually identified since 1996.

In the absence of perfect a automatic CME detector program, the manual identification is still the best way.

The list is necessarily incomplete because of the manual identification.

This data base will serve as a reference to validate automatic identification programs being developed.

The catalog is web based and fully searchable with plots, movies, and measured parameters of CMEs.

The data base is open to all.

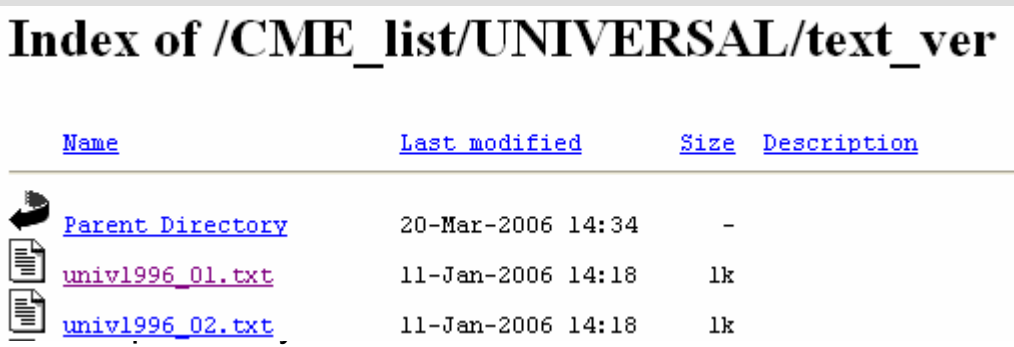
2. Top Level

The CME catalog is arranged as an *YEAR X MONTH* Matrix. Each matrix element Is a link to all the CMEs identified in the corresponding month

SOHO LASCO CME CATALOG

YEAR	MONTH											
1996	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

- Click on month to get the list of CMEs for that month
- A complete description of the catalog
- Text only version
- Search the entire catalog
- Related Links



Index of /CME_list/UNIVERSAL/text_ver

Name	Last modified	Size	Description
Parent Directory	20-Mar-2006 14:34	-	
univ1996_01.txt	11-Jan-2006 14:18	1k	
univ1996_02.txt	11-Jan-2006 14:18	1k	

3. Monthly List

The monthly list is a 13-column html table containing the basic measurements movies, and plots for each CME identified in a given month.

- CME heights (with respect to the disk center) are measured at the fastest segment of the leading edge.
- PA= Position Angle measured from Solar North in degrees (counter-clockwise)
- Halo CMEs are indicated in the "Central PA" column. The letters ("S", "BA", "OA") in the brackets show type of halo CMEs. See examples.
- Click on date to view Java script movie of the CME.
- Click on time to see height-time measurements as a text file.
- Click on speed to view height-time plots of the CME.
- Beware of data gaps. Check for LASCO/C2 data gaps here.

```
# LASCO C2 downtimes
2005/08/08 17:46 - 2005/08/08 21:42
2005/08/09 20:42 - 2005/08/10 00:40
```

- A complete description of the catalog
- Click here to search the entire catalog.

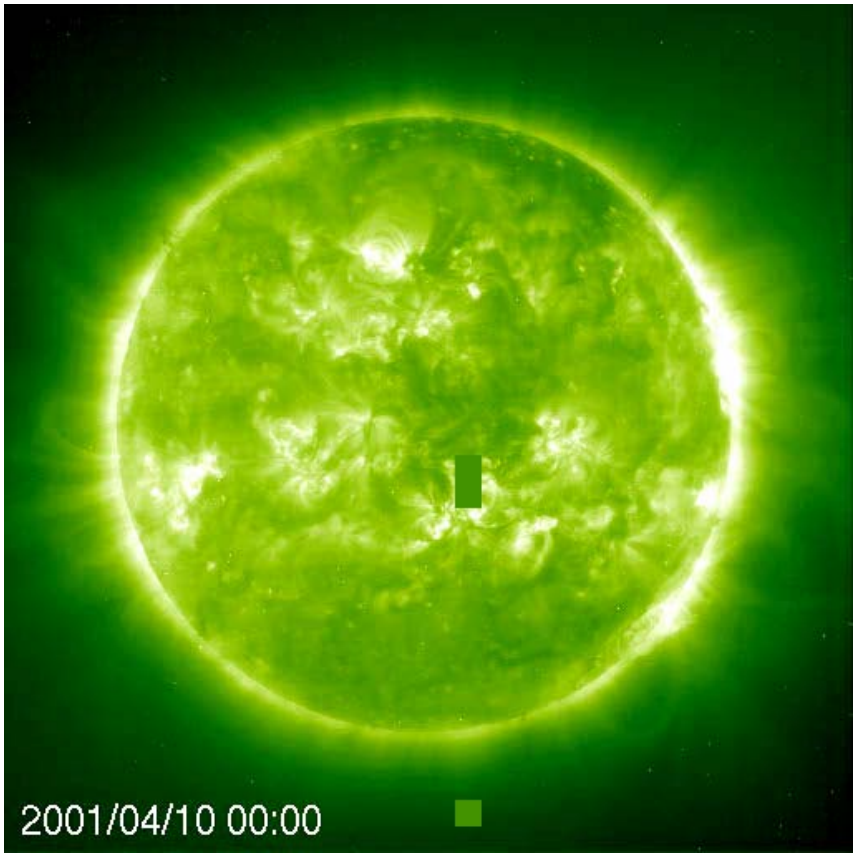
Links to daily movies at NRL site

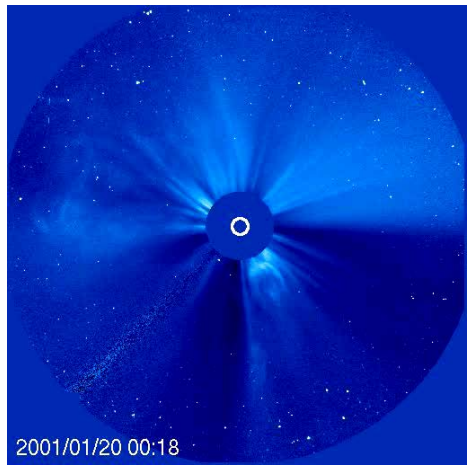
First C2 Appearance Date	Time [UT]	Central PA [deg]	Angular Width [deg]	Linear Speed [km/s]	2nd-order Speed at final height [km/s]	2nd-order Speed at 20 Rs [km/s]	Accel [m/s^2]	Mass [gram]	Kinetic Energy [erg]	MPA [deg]	Daily Movies and Plots	Remarks
2005/08/01	12:54:05	104	22	463	181	0	-1.4.1*1	----	----	99	C2 C3 195 FHTX DST Java Movie	Only 3 points
2005/08/01	14:30:21	83	93	984	1128	1065	17.9	----	----	68	C2 C3 195 FHTX DST Java Movie	

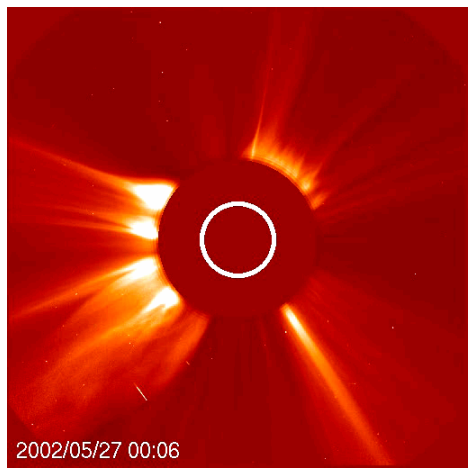
Plots of SEPs and Dst to check SEPeffectiveness, geoeffectiveness and flare association

C2, C3 Java movies (direct and differenced) with superposed EIT 195 images; movies comparing CMEs with Wind/WAVES radio bursts & X-ray flares

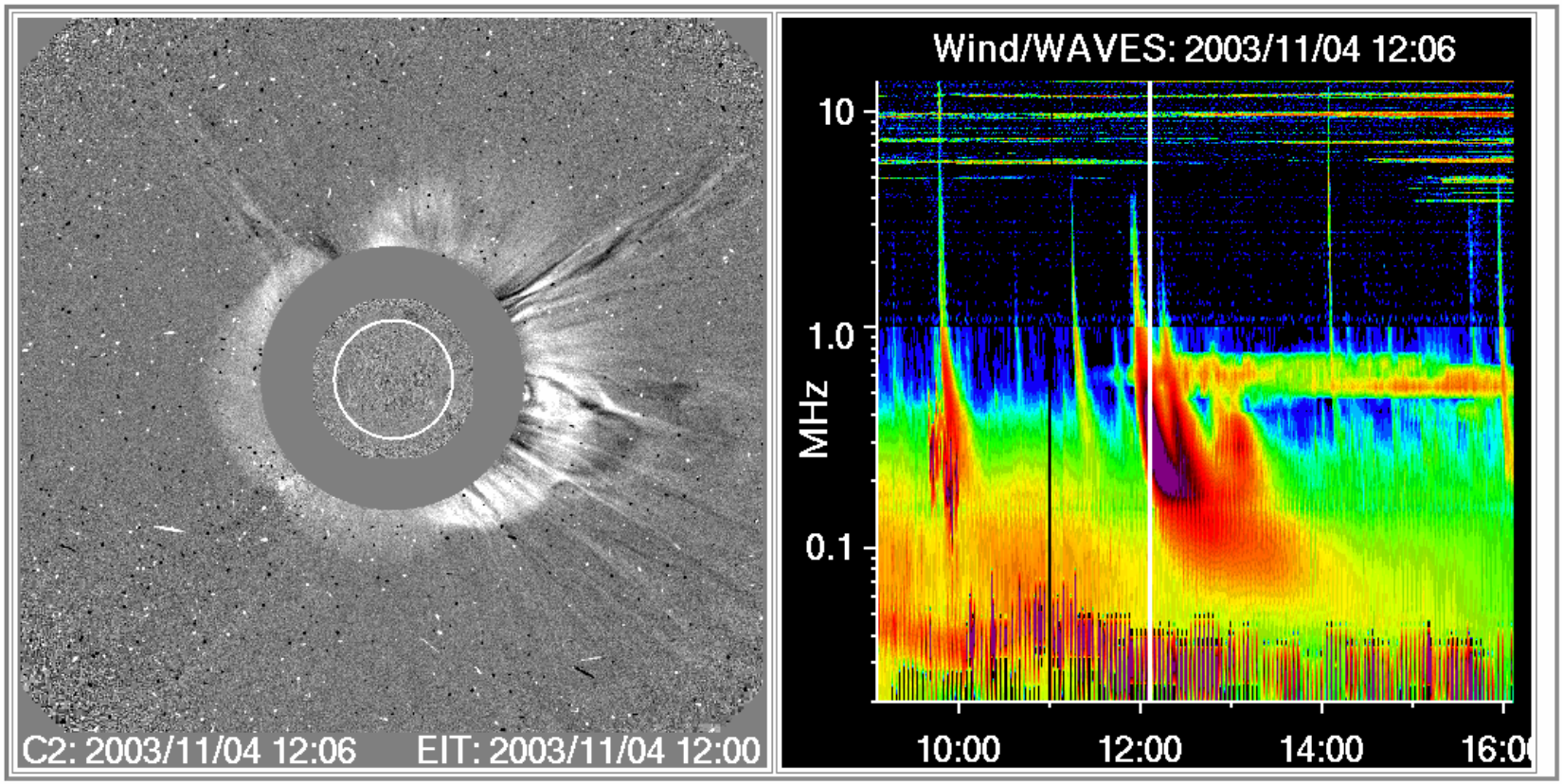
195, C3 195 Movies





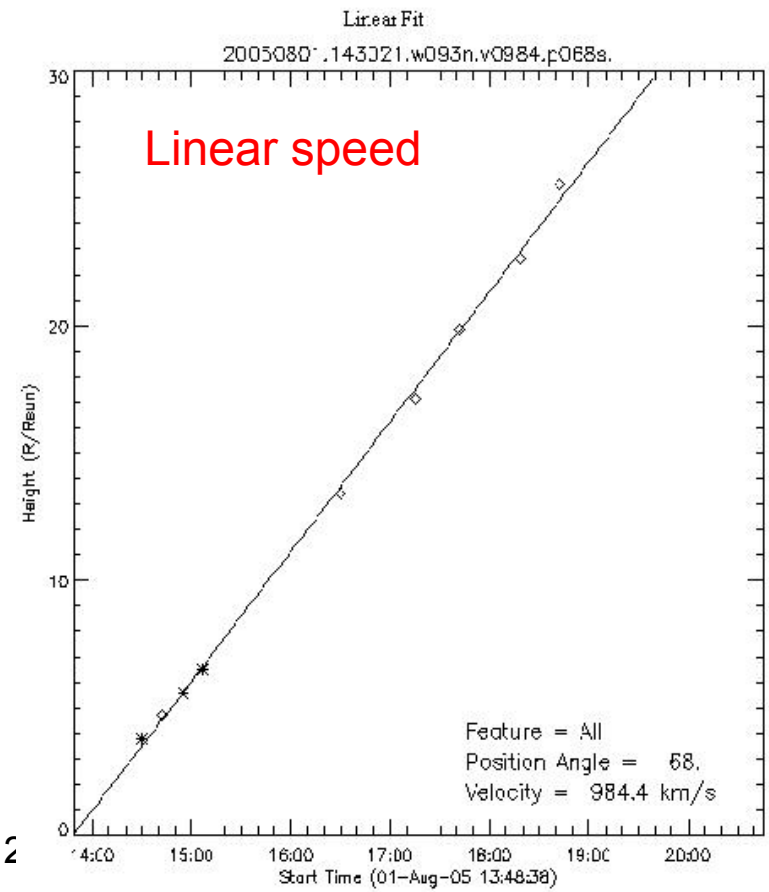


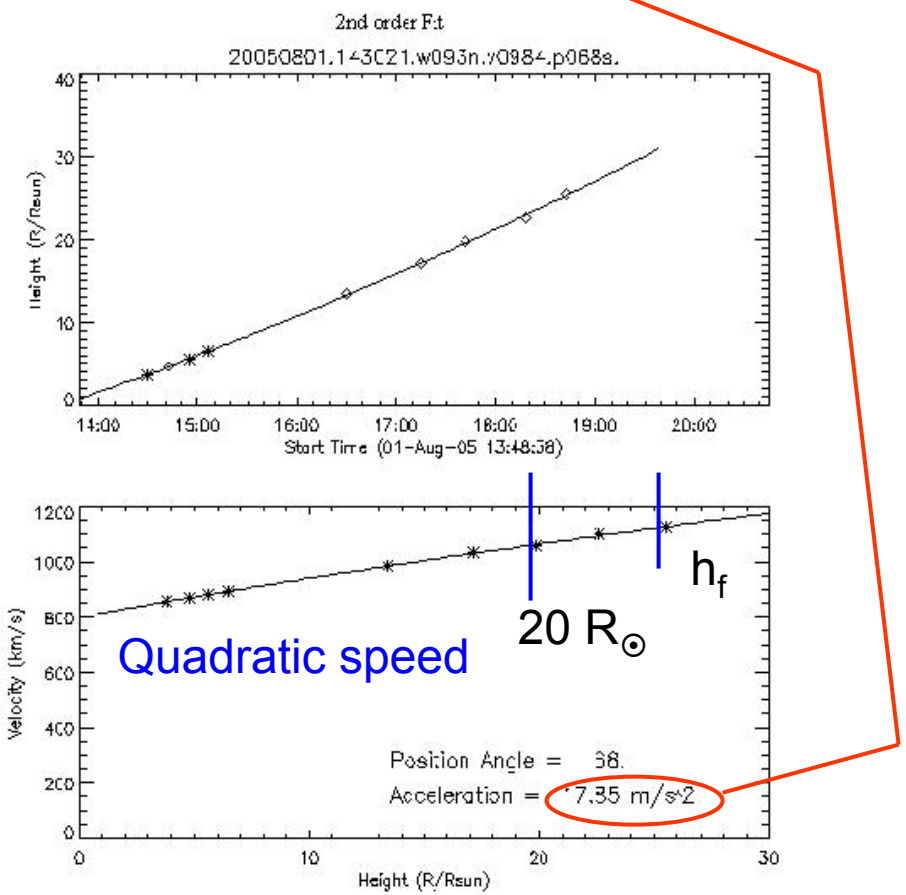
Java Movie: SOHO + Wind



4. Kinematics

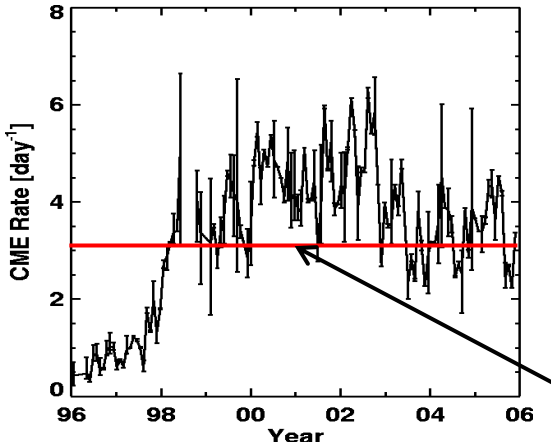
Each CME is characterized by three speeds: (1) the linear speed obtained by fitting a straight line to the height-time measurements, (2) quadratic speed obtained by fitting a parabola and evaluating the speed at the time of final height (h_f) measurement, and (3) speed obtained as in (2) but evaluated when the CME is at a height of 20 $R_\odot$. Acceleration is obtained from the quadratic fit. All quantities refer to the sky plane.





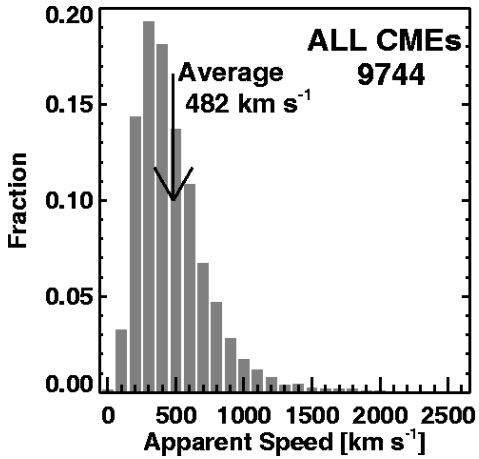
5. Some Statistical Properties

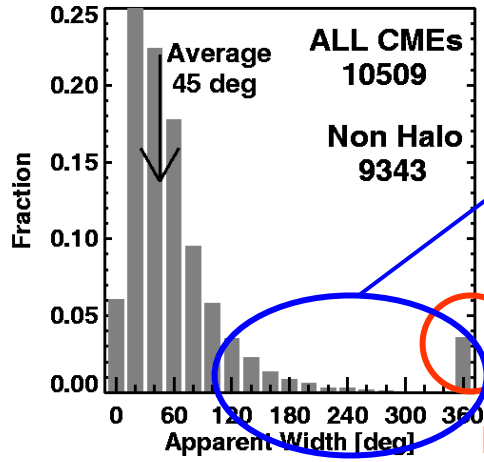
The CME rate averaged over Carrington Rotation periods. Max rate >6/day. Rate in 2005 >2. Some narrow CMEs may not have been detected by LASCO due to visibility



Highest pre-SOHO rate

The average speed is similar to pre-SOHO values. Speed range: <100 km/s to >3000 km/s



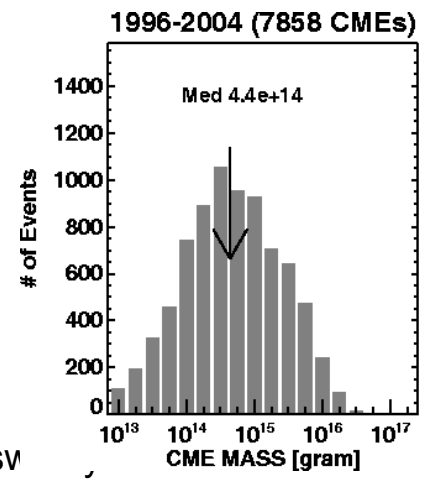


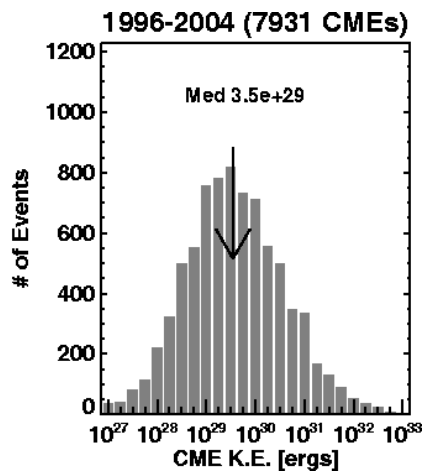
Wide events ~11%

Full halos ~3%

Width of CMEs excluding the wide ones is 45 deg, similar to pre-SOHO values.

Most CMEs show an initial increase before reaching a quasi-constant value, which is listed in the catalog. The mass estimates of halo CMEs are also very uncertain. The kinetic energy is obtained from the linear speed and the cataloged mass. The average CME mass is smaller than the pre-SOHO values because LASCO observes a lot of low-mass CMEs due to high sensitivity

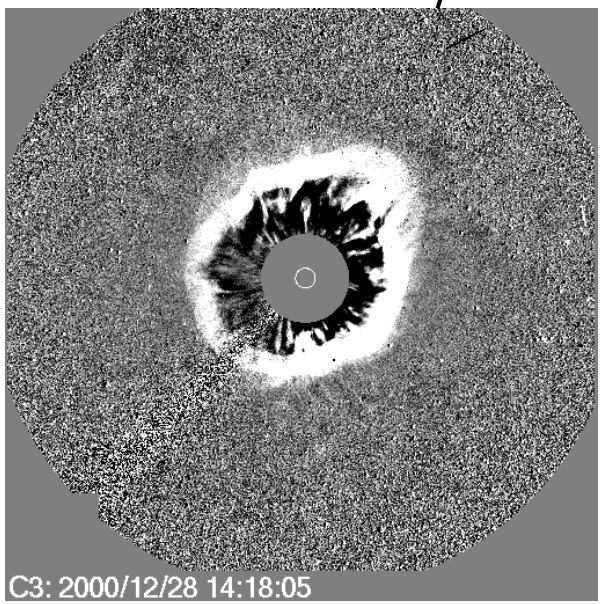


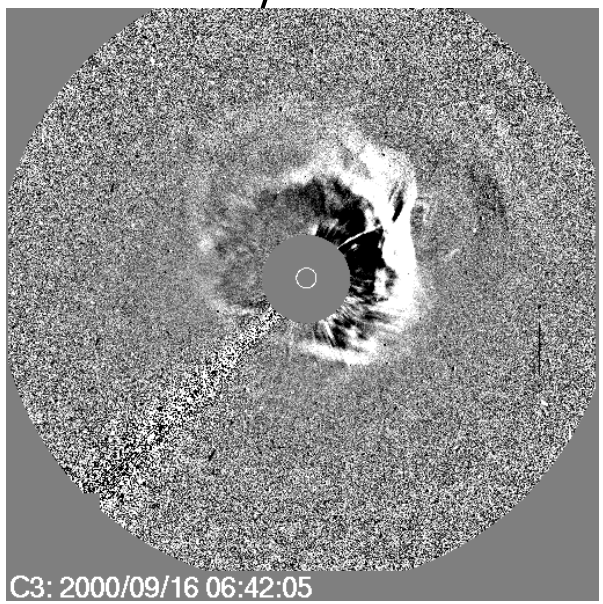


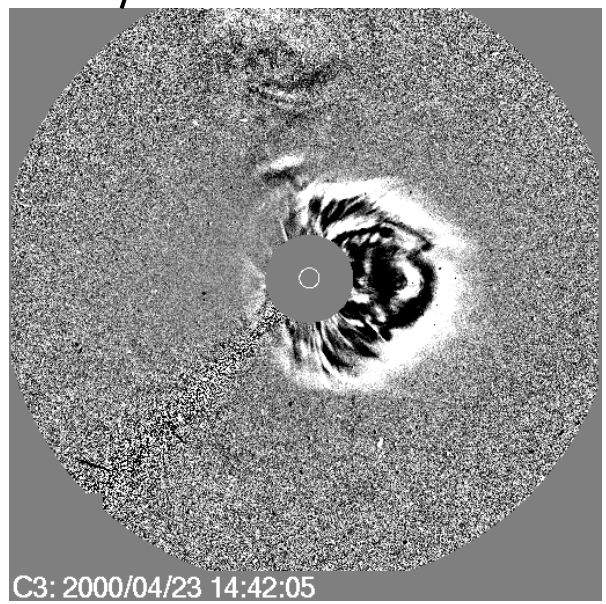
6. Halo CMEs

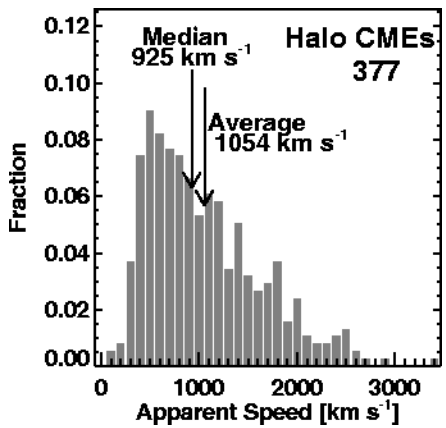
Halo CMEs are marked as such in the “Central PA” column of the monthly list. Halos are classified as symmetric (S), brightness-asymmetric (BA), and outline-asymmetric (OA).

Create Separate Halo CME catalog using search









Halo CMEs were seldom observed in the pre-SOHO era.
-First identified by Howard et al. (1982) from Solwind data
-About 3% of SOHO CMEs are halos.
-Halo CMEs seem to be faster on the average
-Halos are also expected to be intrinsically wide
-These are highly geoeffective when front-sided

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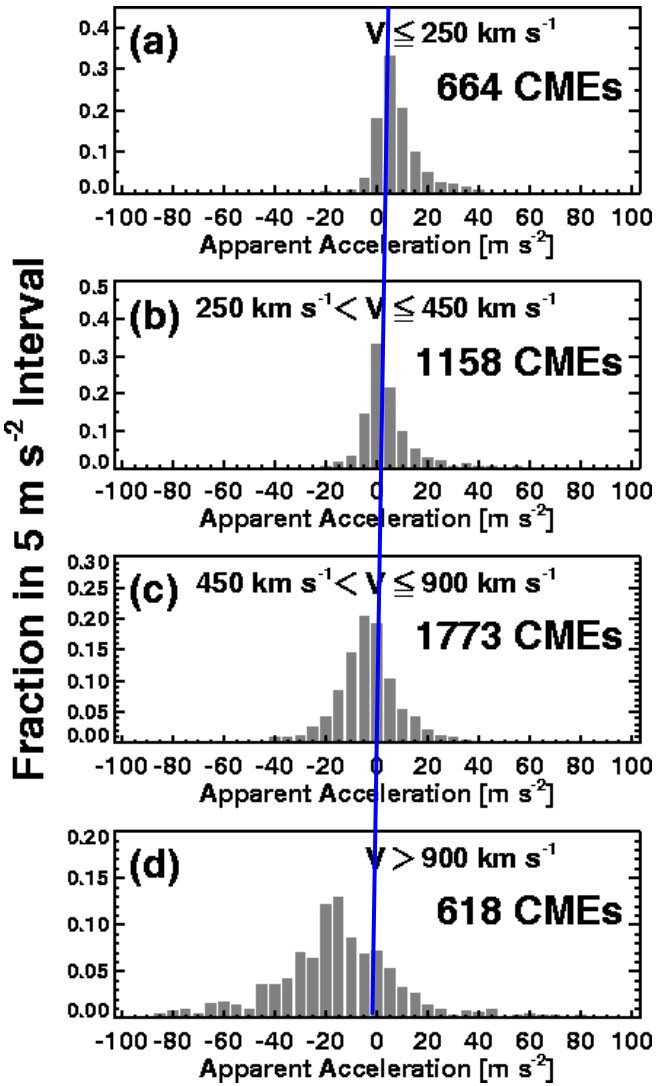
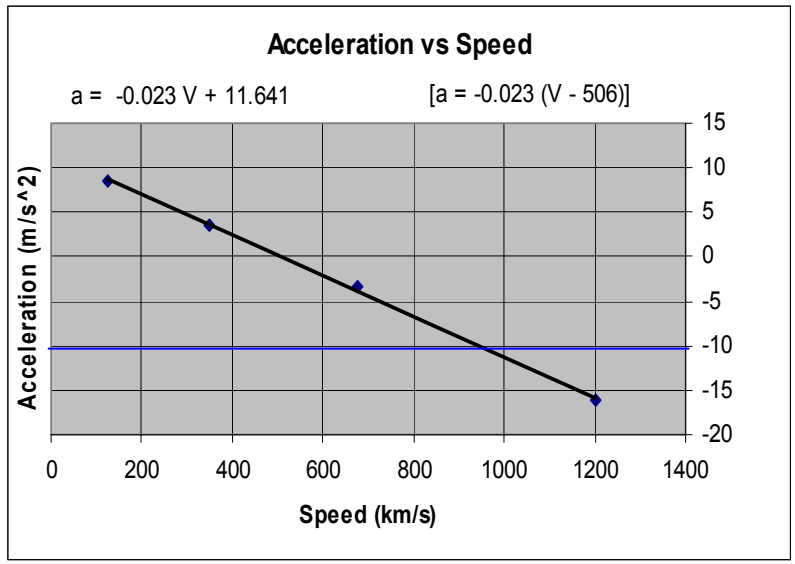
7. Acceleration

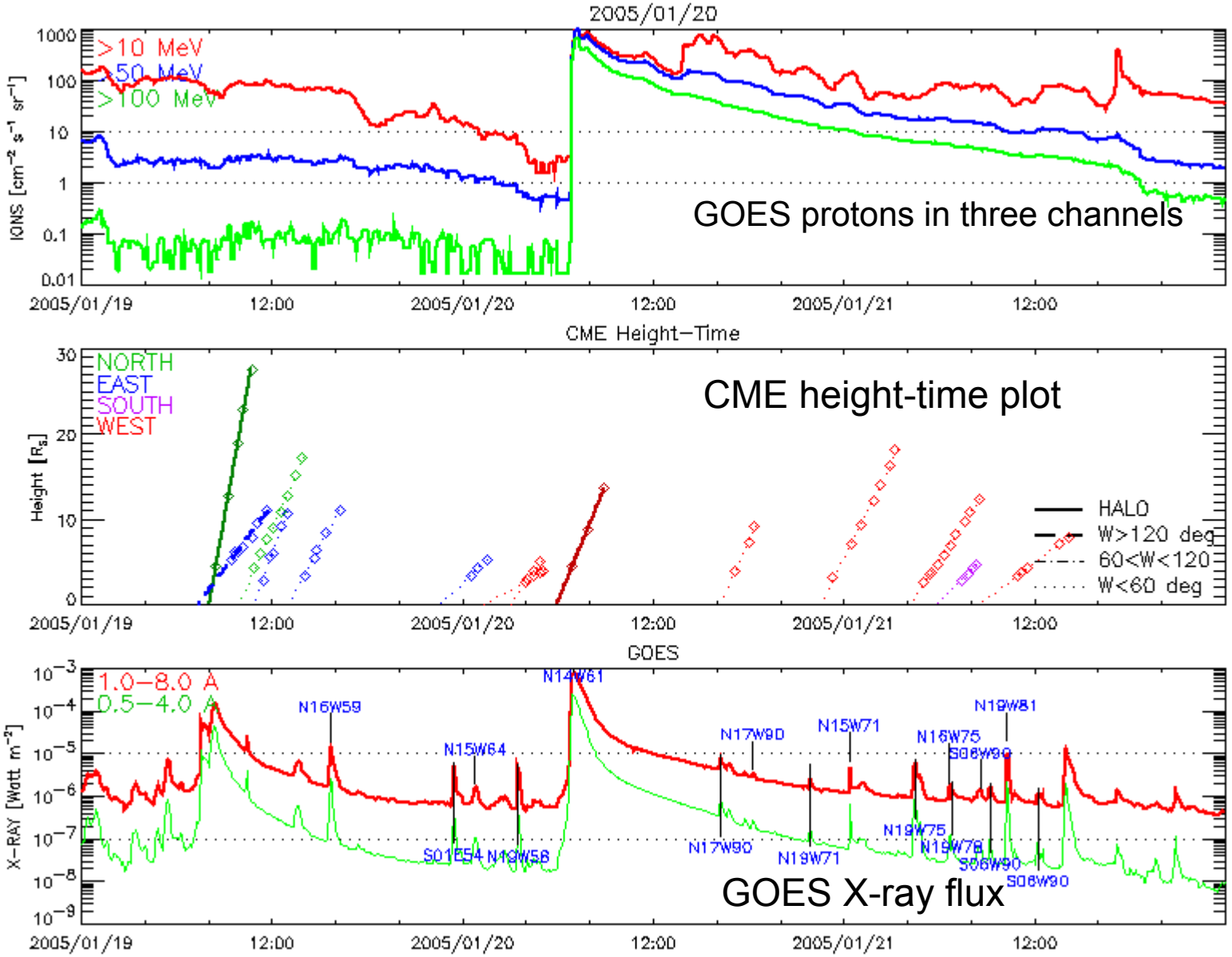


The acceleration of a CME can be positive, negative or close to zero meaning CMEs speed up, move with constant speed or slow down within the LASCO FOV. A minimum of three height-time measurements are needed to estimate the acceleration, but the accuracy increases when there are more measurements.

The acceleration changes sign at Speeds >500 km/s due to coronal drag



8. Proton-Height/time-X-ray (PHTX)



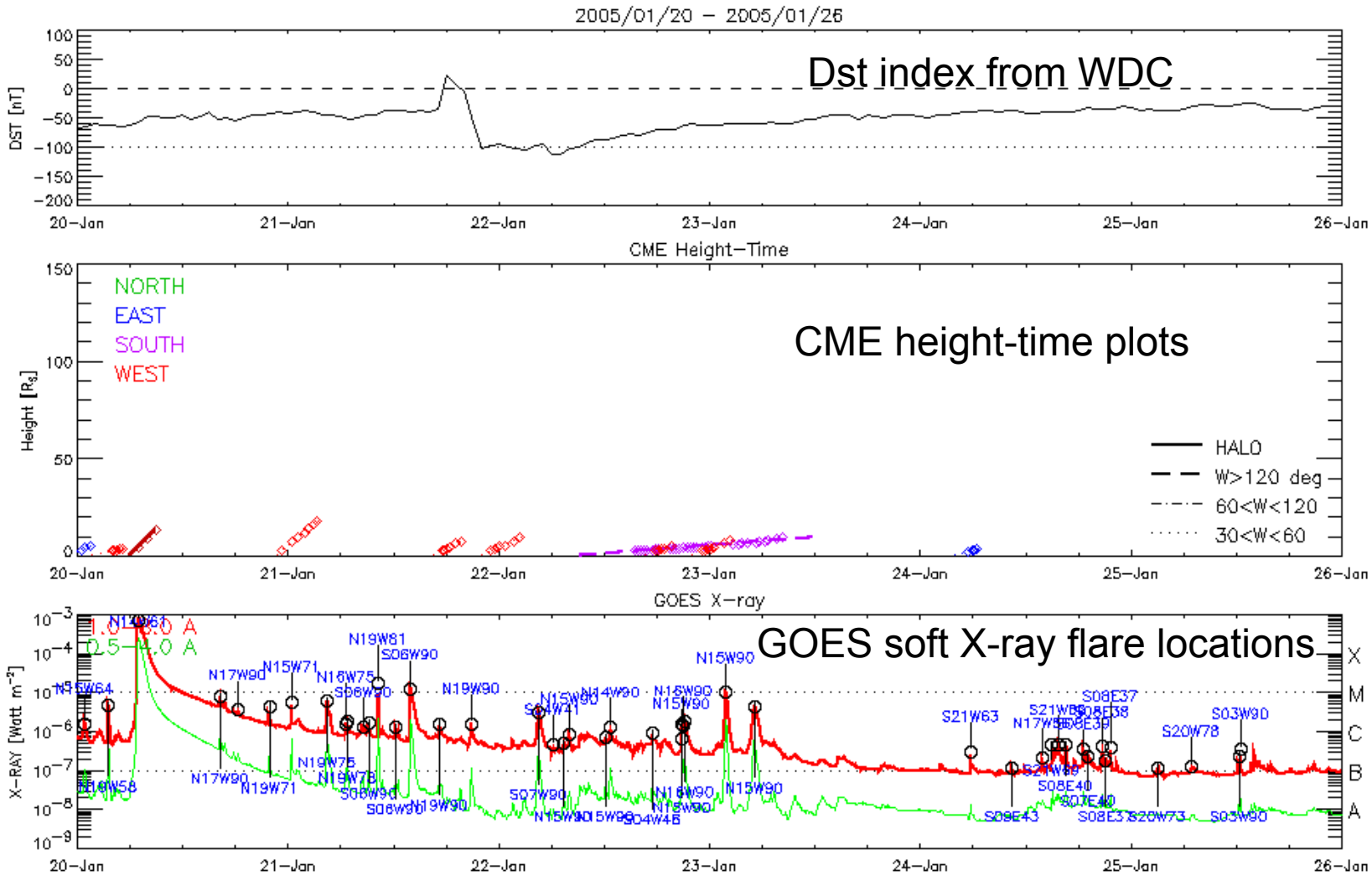
3-day plots useful for connecting CMEs, flares, and SEPs.

The flare locations are also given.

This major SEP event was associated with an ultrafast CME and a major flare

9. Dst plots

6-day plots showing the connection between CMEs and geomagnetic storms. The GOES soft X-ray plot gives the flare locations, useful for identifying the solar source location of CMEs.



10.The Catalog can be searched

***SolarSoft* CME Search**

SoHO LASCO CME Catalog Search Hosted By The CDAW Data Center

1. Select Start and Stop times - all times are *Universal Time*
2. Push SEARCH when ready or Reset to clear entries

Start Time: 00 : 00 Date: 11 Jan 1996

Stop Time: 00 : 00 Date: 1 Nov 2005
(Default FORM times reflect full CME catalog)

Linear Speed >=1000 km/s

Angular Width =360 degrees

Acceleration -2000~-1 m/s^2

Mass grams

Central Position Angle degrees

The search returns an html table (similar to the monthly list with a reduced set of parameters) and an "Event Summary" which gives (1) the LASCO/C2 image of first CME appearance (difference image with EIT images superposed), (2) the GOES (1-8 A) soft X-ray profile with the time of the LASCO/C2 frame marked by a vertical line, (3) the height-time plot with linear fit, and (4) a simple html table giving the time of first appearance, extrapolated onset time at 1 solar radius, number of CMEs in the range searched, search criteria used, and the number of CMEs meeting the search criteria.

11. Summary

- The SOHO/LASCO CME catalog contains > 10^4 CMEs, an order of magnitude higher than the pre-SOHO number.
- The catalog can be searched on the CDAW site and from the VSO and EGSO sites
- The additional data products such as the PHTX and DST plots are useful for Sun-Earth connection investigations.
- The catalog is a living list. Occasional missing CMEs are inserted when found
- Visit http://cdaw.gsfc.nasa.gov.

Publications, which describe CMEs and their properties (http://cdaw.gsfc.nasa.gov/publications)

Gopalswamy, N., A. Lara, S. Yashiro, S. Nunes, and R. A. Howard, Coronal Mass Ejection Activity During Solar Cycle 23, In Solar variability as an input to the Earth's environment. Ed.: A. Wilson. ESA SP-535,, p. 403, 2003

Gopalswamy, N., Nunes, S., Yashiro, S. and Howard, R. A., Variability of Solar Eruptions during cycle 23, Adv. Space Res., 34(2), 391, 2004.

Gopalswamy, N., A global picture of CMEs in the inner heliosphere, in The Sun and the Heliosphere as an Integrated System, edited by G. Poletto and S. T. Suess, Kluwer, Boston, Chapter 8, p. 201, 2004

St. Cyr, O. C. et al., Properties of coronal mass ejections: SOHO LASCO observations from January 1996 to June 1998, J. Geophys. Res., 105, 18169, 2000.

Vourlidas, A., Buzasi, D., Howard, R. A., and Esfandiari, E., Mass and energy properties of LASCO CMEs, Solar variability: from core to outer frontiers, Ed. A. Wilson. ESA SP-506, Vol. 1. Noordwijk: ESA Publications Division, p. 91, 2002

Yashiro, S., N. Gopalswamy, G. Michalek, O. C. St.Cyr, S. P. Plunkett, N. B. Rich, and R. A. Howard, A catalog of white light coronal mass ejections observed by the SOHO spacecraft, J. Geophysical Res., 109, A07105, 2004